



urn:lsid:zoobank.org:pub:6CC8A3EA-F9AE-4057-BD4F-E4975CAC50DA

A new species of green pit viper of the genus *Trimeresurus* Lacépède, 1804 (Reptilia: Serpentes: Viperidae) from the Nicobar Archipelago, Indian Ocean

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Abstract.—A new species of green pit viper of the genus *Trimeresurus*, in the *T. albolabris* complex, is described from Car Nicobar Island of the Nicobar Archipelago, Indian Ocean. The new species, *Trimeresurus davidi* sp. nov., can be distinguished from all other members of this group by the following characteristics: medium to large body size (277–835 mm SVL); dorsal scales in a series of 21–25:21–23:15–17 rows; nasal partly fused with the first supralabial; 166–179 ventrals, 58–70 subcaudals; one preocular; 2–3 postoculars; 10–12 supralabials; 12–15 infralabials; two internasals usually in contact with each other; 11–14 cephalic scales; verdant green dorsal and ventral color, absence of white ventrolateral stripes along the sides of the body; males with a white supralabial streak, bordered by a reddish tinge above; a pair of white and red stripes along the sides of the tail in both sexes; a reddish brown colored tail and a greenish iris. The new species is endemic to Car Nicobar Island of the Nicobar Archipelago, and should be regarded as an Endangered species owing to its restricted distribution range.

Keywords. Endangered, endemic species, Nicobar Islands, Reptilia, Squamata, *Trimeresurus albolabris* complex

Citation: Chandramouli SR, Campbell PD, Vogel G. 2020. A new species of green pit viper of the genus *Trimeresurus* Lacépède, 1804 (Reptilia: Serpentes: Viperidae) from the Nicobar Archipelago, Indian Ocean. *Amphibian & Reptile Conservation* 14(3) [Taxonomy Section]: 169–176 (e264).

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Accepted: 14 October 2020; **Published:** 1 November 2020

Introduction

Asian pit vipers of the genus *Trimeresurus* Lacépède, 1804 are currently represented by 50 species ranging from the Western Ghats of peninsular India in the west to the Lesser Sunda Islands in the east (Uetz et al. 2020; Vogel 2008). Among these species, the white-lipped green pit vipers include five species in the *T. albolabris* complex, which constitute nearly 10% of the diversity, and their collective geographic distribution ranges from the Western Himalayan Mountains (for *T. septentrionalis*; Kramer 1977) in the west to the Lesser Sunda Islands (for *T. insularis*; Kramer 1977) in the east (Vogel 2008; Kramer 1977; Mirza et al. 2020; Chen et al. 2020; Uetz et al. 2020). The white-lipped pit vipers are currently classified under the subgenus *Trimeresurus* under the genus *Trimeresurus* (David et al. 2011). Two new members, namely *T. salazar* Mirza, Bhosale, Phansalkar, Sawant, Gowande, Patel, 2020 and *T. caudornatus* Chen, Yu, Vogel, Shi, Song, Tang, Yang,

Ding, Chen, 2020, have recently been added to this group (Mirza et al. 2020; Chen et al. 2020). One member of this species complex, traditionally identified as *Trimeresurus albolabris* Gray, 1842 (Smith 1943; Vijayakumar and David 2006), has been reported from Car Nicobar Island of the Nicobar Archipelago in the past (Smith 1943; Vijayakumar and David 2006; Vogel et al. 2014). Herein, we reassess the systematic status of this insular population of *Trimeresurus* and provide evidence for its specific distinction from *T. albolabris sensu stricto*, thereby describing it as a species new to science.

Materials and Methods

Pit vipers of the genus *Trimeresurus* encountered in the field (on Car Nicobar) were carefully restrained, measured, and scored for morphological characters, followed by their release back into their native habitat. One dead specimen from Chuckchucka Village (9.2179°N, 92.8003°E, 6 m asl), Car Nicobar, was collected and deposited in the collection

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Fig. 1. Holotype (BNHS 3304) of *Trimeresurus davidi* sp. nov. Photo by Rahul Khot.

of the Department of Ocean Studies and Marine Biology, Pondicherry University (DOSMB), Port Blair, India. Six specimens of this species available in the collections of the Natural History Museum, London (NHMUK), which were collected during Lord Moyné's expedition to the Nicobar Islands (Smith 1943), were examined for comparison. One additional specimen deposited in the collections of the Bombay Natural History Society (BNHS) was studied and ascribed to this species.

The following characters were recorded: snout-vent length (SVL); tail length (TaL); total length (TL; SVL+TaL); head length, measured from the snout tip to the jaw angle (HL); head width at the level of the eyes (HW); maximum head depth (HD); horizontal diameter of the eye (ED); eye-nostril distance (EN); snout length, from anterior margin of the eye to snout tip (ES); inter-orbital distance, measured dorsally as the distance between the eyes (IO); inter-narial distance, measured as the distance between the nares (IN); dorsal scale-rows near neck, at midbody and near tail (DSR); number of cephalic scales, counted in a horizontal series between the elongated supraoculars (CEP); and ventrals, counted following Dowling (1951). The sex of the specimens was determined by examination for presence or absence of hemipenis by palpating the tail, coupled with the relative tail length, expressed as the ratio of tail length to the total length of the snake (TaL/TL). Individuals with incomplete/regenerated tails (bold values in Table 2) are excluded from the relative tail length range. Geographic coordinates of the localities of the specimen occurrences were recorded with a Garmin GPSMAP 78s and mapped with ARC MAP v. 10.

Museum acronyms for comparative specimens examined (Appendix 1) are as follows: NHMUK: Natural History Museum [formerly the British Museum (Natural History)], London, United Kingdom; CAS: California Academy of Sciences, San Francisco, California, USA; CIB: Chengdu Institute of Biology, Chengdu, People's Republic of China; MHNG: Muséum d'Histoire Naturelle, Ville de Genève, Switzerland; MNHN: Muséum National d'Histoire Naturelle, Paris, France; NMW: Naturhistorisches Museum Wien, Austria; RMNH: Nationaal Natuurhistorisch Museum (Naturalis), Leyden, The Netherlands; NHMB: Naturhistorisches Museum Basel, Switzerland; SMF: Natur-Museum und Forschungs-Institut Senckenberg, Frankfurt-am-Main, Germany; ZMB: Zoologisches Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin, Germany; ZMH: Zoologisches Museum Hamburg [formerly Zoologisches Institut und Museum], Universität Hamburg, Hamburg, Germany; ZSI: Zoological Survey of India, Kolkata [Calcutta], India.

Systematics

Trimeresurus davidi sp. nov. (Figs. 1–2)

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Trimeresurus albolabris – Vijayakumar and David (2006).

Trimeresurus albolabris – Smith (1943) part, Vogel (2008) part, Vogel et al. (2014) part.



Fig. 2. *Trimeresurus davidi* sp. nov. in life from Car Nicobar (top and middle: males, bottom: female).

Holotype. BNHS 3304, an adult female from Chuckchucka Village (9.2161°N, 92.8109°E, 14 m asl), Car Nicobar, collected by a group of Nicobari men (*vide* Vijayakumar and David 2006).

Paratypes. DOSMB 05104, an adult male from Chuckchucka Village, Car Nicobar; NHMUK 1936.7.7.40, NHMUK 1936.7.7.41, NHMUK 1936.7.7.42, (three adult females from ‘Car Nicobar, Nicobar Is.’), NHMUK 1936.7.7.46 an unsexed adult from ‘Car Nicobar, Nicobar Is.’, NHMUK 1936.7.7.47 and NHMUK 1936.7.7.48 (two adult males from ‘Nicobar Is.’ and ‘Andaman Is.’ [doubtful], respectively), collected during Lord Moyne’s expedition to the Nicobar Islands.

Etymology. The specific epithet is a patronym, named in genitive singular case, honoring Patrick David, an eminent reptile taxonomist for his immense contribution to the systematics of Asian pit vipers and, in particular, to the Nicobar snake fauna.

Diagnosis. *Trimeresurus davidi* sp. nov. is an arboreal member of the genus *Trimeresurus* restricted to the Car Nicobar Island of the Nicobar archipelago, characterized by: medium to large sized body (277–835 mm SVL); dorsal scales in a series of 21–25:21–23:15–17 rows; nasal partly fused with the first supralabial; 166–179 ventrals; 46–70 subcaudals; one preocular; 2–3 postoculars;

10–12 supralabials; 12–15 infralabials; two internasals usually in contact with each other; 11–14 cephalic scales; relative tail length (TaL/TL) ranging from 0.143–0.20; dorsal and ventral verdant green in color, lacking white ventrolateral stripes; males with a white supralabial streak, bordered by a reddish tinge above; a pair of white and red stripes along the sides of the tail in both males and females; a reddish brown colored tail and a greenish iris; hemipenis reaching the 13th caudal plate.

Description of the holotype. BNHS 3304, an adult female, in a fairly good state of preservation. Head large (HL/SVL 0.05), longer than broad (HL/HW 1.41); triangular in shape and fairly distinct from a slender neck. Nostrils situated more towards the snout tip than the eyes (EN/ES 0.87). Eyes relatively small and oval (ED/HL 0.2), with a vertically elliptical pupil. Dorsal and lateral head scales smooth and imbricate. Rostral barely visible from above; followed by two large intranasals not in contact with each other. Fourteen cephalic scales in a line between the two elongated supraoculars. Nasal partially fused with the 1st supralabial; 12/12 supralabials; 3rd largest; 14/14 infralabials, of which, the first three contact the anterior chin shields. Loreal pit large and triangular. Two small postoculars; one preocular and crescent shaped subocular scales on either side of the head. Dorsal scales in 23:23:15 rows; with very feeble median longitudinal keels. Ventrals 173; broad and extending throughout the width of the belly; anal single; subcaudals 61; divided. Temporal scales small and smooth. Tail relatively short (TaL/TL 0.146) and prehensile.

Overall dorsal coloration dark grey in preservation, with a pale grey venter. Ventral surface of the tail lighter in color, bearing two incomplete white lateral stripes along the sides. Dorsal surface of the tail is a different color than the body, and of a lighter shade when compared to the body. Ventrolateral stripes absent on the body; white ventrolateral stripes present along the sides of the tail extending from the vent to the 13th subcaudal.

Variation. Measurements and scale counts of the paratypes and referred material are given in Table 1. Mid-body scale rows range from 21–25:21–23:15–17; ventrals range from 170–179 in males and 166–178 in females. Subcaudals range from 67–70 in males and 55–64 in females. Internasals usually in contact with each other, but separated by a small scale in one specimen. Cephalic scales range from 11–14; postoculars range from 2–3. Relative tail length in males: 0.178–0.200; in females: 0.143–0.161. Sexual dimorphism apparent in body for the tail dimensions and the number of subcaudals. Verdant green colored in life, both dorsally and ventrally, without a white ventrolateral pair of stripes along the sides of the body; but with a pair of white and red lateral stripes along the sides of the tail. Males have a thin white labial stripe bordered by red above the supralabials on either side of the head (absent in females)

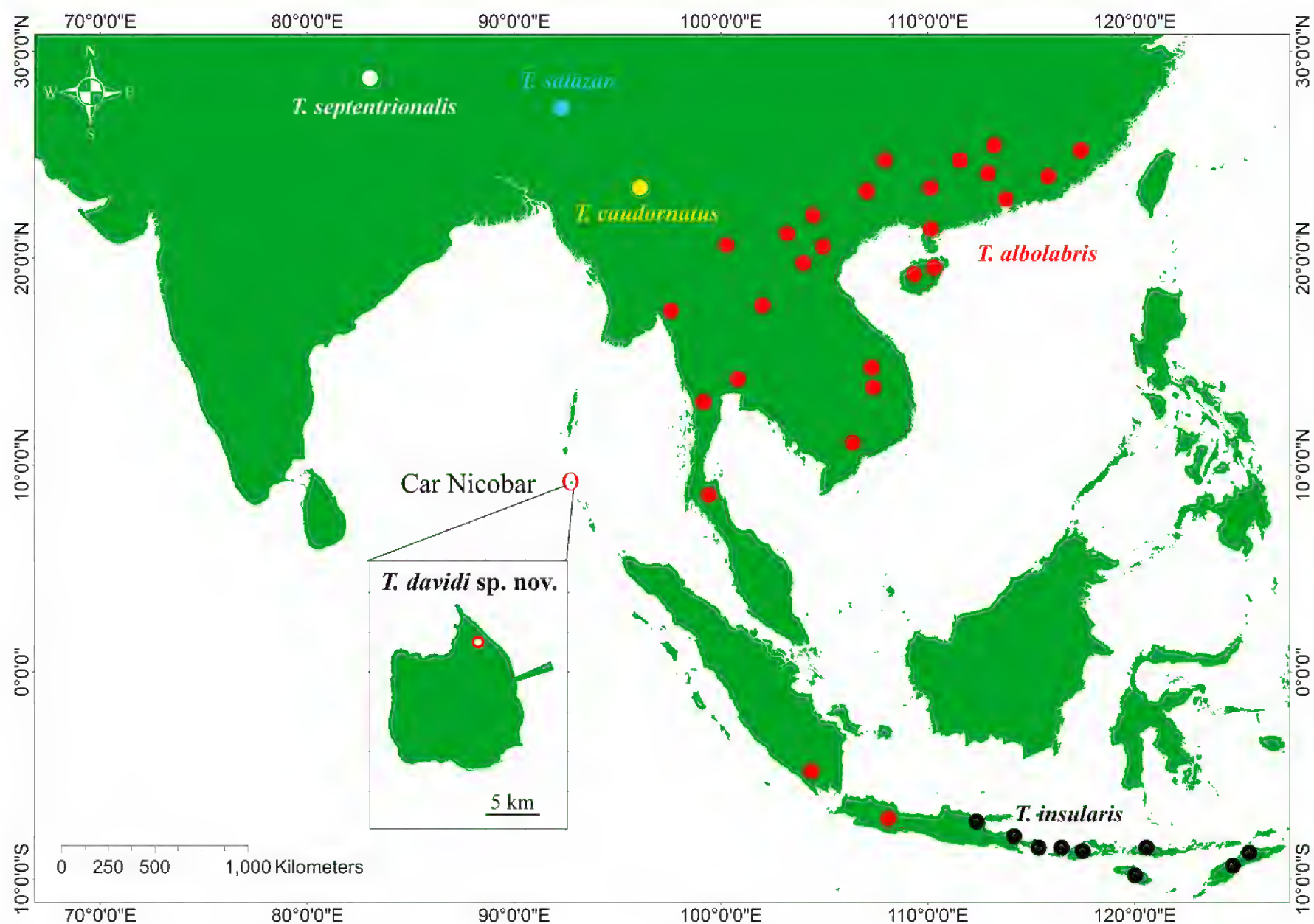


Fig. 3. Distribution of members of the *Trimeresurus albolabris* complex showing the type locality and distribution of *T. davidi* sp. nov.

and a white stripe bordered by red along the subcaudals from the vent until about half the length of the tail (also present in females).

Natural history and distribution (Fig. 3). Five individuals of *T. davidi* sp. nov. were encountered during this study. They were always observed as active and foraging during the night (2100 h and later) and were never encountered during the day. Individuals were seen on shrubs at heights ranging from 1.20 m ($n = 2$) to about 8 m ($n = 1$) above the ground; also seen on the rocky walls of old buildings ($n = 1$). One was found dead in a coconut plantation, presumably killed by someone. The large (~120 cm) female individual observed on the top of a tree at a height of about 8 m had a swollen anterior belly, indicating that it had fed recently. Lizards of the genera *Coryphophylax*, *Bronchocela*, *Cyrtodactylus*, and *Gehyra* were observed at close quarters (~2 m) from the point where the snakes were sighted. Other relatively small-bodied, endemic species of snakes, namely *T. labialis* (Fitzinger in: Steindachner, 1867) and *Lycodon tiwarii* Biswas and Sanyal, 1965, were observed to be sympatric with *T. davidi* sp. nov. and could be potential competitors as they are also nocturnal snakes feeding on prey species similar to *T. davidi* sp. nov.

Comparison. *Trimeresurus davidi* sp. nov. does not have any superficially similar looking, green-colored arboreal congeners on Car Nicobar Island, on which its

distribution is restricted. It can be distinguished from other members of the *T. albolabris* complex by the following combination of characters: dorsal scales of *T. davidi* sp. nov. in 21–25:21–23:15–17 rows (vs. 21–23:19–21:15 in *T. albolabris* and *T. insularis*, 21:21:15 in *T. caudornatus*, 21:19:17 in *T. septentrionalis*, and 21:19:15 in *T. salazar*). There is some overlap in this character, as is expected; however, five of the 11 (45%) examined *T. davidi* specimens had 23 dorsal scale rows at midbody. This character has never been recorded in any of the other species within this complex. Also, there seems to be a certain degree of overlap in scalation characters between the currently recognized members of *T. albolabris* complex, which makes the partially overlapping values with *T. davidi* sp. nov. quite understandable. *Trimeresurus davidi* sp. nov. has 166–179 ventrals (vs. 149–173 in *T. albolabris*, 161–163 in *T. caudornatus*, 160–181 in *T. septentrionalis*, 156–167 in *T. insularis*, and 163–171 in *T. salazar*); an absence of white ventrolateral stripes along the body in *T. davidi* sp. nov. (vs. present in *T. septentrionalis* and *T. salazar*); and the presence of a pair of red and white ventrolateral stripes along the sides of the tail (vs. absent in all other species). *Trimeresurus davidi* sp. nov. is considerably larger than all other species of this complex. For further comparisons, see also the morphological characters (Table 2) for the material examined (Appendix 1) in this study.

From the two other sympatric congeners, *T. andersoni*

Table 1. Measurements (in mm) and pholidosis of *Trimeresurus davidi sp. nov.* (* indicates holotype). Measurements for individuals with a regenerated/incomplete tail are shown in bold.

Voucher number	BNHS3304*		NHMUK 1936.7.7.40		NHMUK 1936.7.7.41		NHMUK 1936.7.7.42		DOSMB 05104		NHMUK 1936.7.7.47		NHMUK 1936.7.7.48		NHMUK 1936.7.7.46		
	Chuckchucka	F	Car Nicobar	F	Car Nicobar	F	Chuckchucka	F	Chuckchucka	Chuckchucka	M	Chuckchucka	M	Chuckchucka	M	Chuckchucka	‘Nicobar Is.’
Locality	Chuckchucka		Car Nicobar		Car Nicobar		Chuckchucka		Chuckchucka		Chuckchucka		Chuckchucka		Chuckchucka		‘Andaman Is.’
Sex	F		F		F		F		F		M		M		M		unknown
SVL	593	750	680	835	360	770	770	334	277	421	459	372	421	459	372		
Tail length	102	135	121	160	60	110	0.125	76	60	99	115	59	99	115	59		
TaL/TL	0.146	0.153	0.151	0.161	0.143	0.125	0.185	0.178	0.190	0.200	0.200	0.137	0.190	0.200	0.137		
Head length	27.37	41.22	36.5	47.21	17.82	43.68	15.4	14.0	21.64	23.58	23.58	20.44	21.64	23.58	20.44		
Head width	19.36	29.15	26.28	31.7	12.36	26.34	13.16	10.32	13.38	12.82	12.82	10.87	13.38	12.82	10.87		
Head depth	11.9	17.48	16	20.81	7.77	16.51	7.98	5.36	8.83	8.61	8.61	7.84	8.83	8.61	7.84		
Eye diameter	5.25	4.48	3.9	5.15	3.33	4.54	2.84	3.19	3.25	3.75	3.75	2.83	3.25	3.75	2.83		
Eye-nostril	7.19	8.17	7.2	9.68	3.37	8.77	3.56	3.2	4.1	5.11	5.11	3.36	4.1	5.11	3.36		
Eye-snout	8.31	9.99	9.29	12.85	6.04	12.31	5.22	4.44	6.32	6.68	6.68	5.38	6.32	6.68	5.38		
Interorbital distance	11.61	16.48	13.34	18.17	9.85	15.24	10	8.19	10.89	9.8	9.8	7.62	10.89	9.8	7.62		
Internarial distance	4.23	11.19	11.85	8.89	3.59	7.03	3.8	3.26	3.33	4.25	4.25	2.75	3.33	4.25	2.75		
Supralabials	12	11	10	12	10	10	10	10	10	11	11	10+	10	11	10+		
Infralabials	14	13	14	15	12	15	12	13	12	13	13	13	12	13	13		
Preoculars	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Postoculars	3	2	2	3	2	2	3	2	2	2	2	dry/damaged	2	2	2		
Dorsal scale rows	23:23:15	23:21:15	25:23:16	25:23:17	21:21:17	23:23:15	25:23:15	21:21:15	24:21:15	21:21:15	21:21:15	22:22:16	24:21:15	21:21:15	22:22:16		
Ventrals	173	173	170	166	168	178	179	175	172	170	170	168	172	170	168		
Subcaudals	61	58	58	64	63	55	67	68	70	68	68	46	70	68	46		
Anal	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Subocular	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Internasal	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2		
Internasals	separated	contact	contact	contact	contact	contact	contact	contact	contact	contact	contact	contact	contact	contact	contact		
Cephalics	14	11	11	12	13	11	12	12	11	12	12	11	11	12	11		

A new species of *Trimeresurus* from Nicobar Archipelago

Table 2. Comparison of morphological characters within the *Trimeresurus albolabris* group, adapted from Chen et al. (2020), Mirza et al. (2020), and Grismer et al. (2008) in addition to the specimens examined during this study, the numbers of which are given under each species name.

Character	<i>T. davidi</i> sp. nov. <i>n</i> = 11	<i>T. albolabris</i> <i>n</i> = 46	<i>T. insularis</i> <i>n</i> = 7	<i>T. salazar</i> <i>n</i> = 6	<i>T. septentrionalis</i> <i>n</i> = 18	<i>T. caudornatus</i> <i>n</i> = 2
Mid-body scale rows	21–23	19–21	19–21	19–21	19–21	21
Ventrals	166–179	149–173	156–168	163–171	160–181	161–163
Subcaudals	58–70	48–67	54–75	59–74	55–83	52–72
SVL	277–835	297–668	418–613	363–415	454–675	425–537
TaL	60–160	31–146	115	60–94	104–197	77–122
TaL/TL	0.14–0.20	0.19–0.24	0.21–0.35	0.14–0.18	0.19–0.24	0.15–0.19
Ventrolateral body stripes	absent	present/absent	absent	present	present	absent
Ventrolateral tail stripes	present	absent	absent	absent	absent	absent

Theobald, 1868 and *T. labialis* Fitzinger in: Steindachner, 1867, *T. davidi* sp. nov. can be distinguished by its verdant green dorsal coloration (vs. predominantly brown in both *T. andersoni* and *T. labialis*); midbody dorsal scales in 21–23 rows (vs. 23–25 in *T. andersoni*, 23 in *T. labialis*); and the first supralabial united with the nasal in *T. davidi* sp. nov. (vs. separate in *T. labialis*).

Additionally, from the green color morph of *Trimeresurus cantori* (Blyth 1846) which occurs on islands of the central group of the Nicobar archipelago, *T. davidi* sp. nov. can be distinguished by a lower number of mid-body scale rows (21–23 in *T. davidi* sp. nov. vs. 25–29 in *T. cantori*); and the absence of a pair of white ventro-lateral stripes along the sides of the body in *T. davidi* sp. nov. (vs. present in *T. cantori*) [Whitaker and Captain 2008].

Discussion

Among the members of the genus *Trimeresurus*, *T. albolabris* has been and continues to be shown as comprising multiple cryptic lineages across its known distribution range in various parts of Southeast Asia (Kramer 1977; Zhu et al. 2016; Chen et al. 2020; Mirza et al. 2020). Currently, this complex comprises five species spanning a distribution across the Western Himalayan Nepal in the west to the Lesser Sunda Islands in the east. Herein, *T. davidi* sp. nov. has been added as a sixth member, occurring towards the southwestern extremity of the distribution range of the *T. albolabris* complex. This population has been known since Smith (1943: 524) mentioned six Nicobarese specimens, three males and three females, collected by Lord Moyne from Car Nicobar. He also remarked that these specimens lack the light flank stripe on the body, but have an unusually distinct one along the sides of the tail. The specimens described here from Car Nicobar also show this unique ventrolateral tail stripe.

Car Nicobar Island, to which *T. davidi* sp. nov. is restricted, is a small island of about 125 km². With a nearly flat terrain and a maximum elevation of about 90 m asl, it is fairly densely populated. However, Car Nicobar does

not have any protected areas such as national parks or wildlife sanctuaries and hence, a species such as *T. davidi* sp. nov. which is restricted only to this island is under a high level of threat. Unfortunately, the local Nicobarese people usually kill such snakes when encountered. Instances of bites from this species have been known (Vijayakumar and David 2006), and in one case a casualty was reported (Edmond, pers. comm.). According to the current data on its geographic distribution and abundance, we recommend that *T. davidi* sp. nov. be regarded as an Endangered species, following the criteria B1 (extent of occurrence < 5000 km²) and B2 (area of occupancy < 500 km²) of the IUCN guidelines, which indicates a need for immediate conservation attention. There are two other sympatric pit viper species on Car Nicobar, namely *T. labialis* Fitzinger in Steindachner, 1867 and *T. andersoni* Theobald, 1868 (Vogel et al. 2014). Of these, *T. labialis* shows a similar pattern of distribution to *T. davidi* sp. nov. by being endemic to this one single island, while the other species (*T. andersoni*) is known to occur throughout the Andaman archipelago as well (Whitaker and Captain 2008).

Acknowledgements.—We thank the Department of Environment and Forests, Andaman and Nicobar Islands for permission (permit numbers: CWLW/WL/134/(J)/Folder/417 and CWLW/WL/134 (L)/60) to conduct this study and for the infrastructure provided. SRC thanks Prof. K.V. Devi Prasad and the faculty of the Department of Ecology and Environmental Sciences and the Department of Ocean Studies and Marine Biology, Pondicherry University, for the lab space and other support they extended. Edmond (forest laborer) assisted with the fieldwork and provided logistics, for which we are grateful. SRC thanks the Mohamed bin Zayed Species Conservation Fund for a grant (#160514249) which partly facilitated this study. We thank Rahul Khot and Omkar Adikari (BNHS) for pictures and data from the specimens under their care. We thank Jens Vindum and Alan Leviton (CAS), Yuezhao Wang, Xiaomao Zeng, Jiatang Li, and Ermi Zhao (CIB), Andreas Schmitz (MHNG), Denis Vallan and Raffael Winkler (NHMB),

Alain Dubois and Annemarie Ohler (MNH), Silke Schweiger, Richard Gemel, and Georg Gassner (NMW), Pim Arntzen and Esther Dondorp (RMNH, Leiden), Mark-Oliver Rödel and Frank Tillack (ZMB), Jakob Hallermann (ZMH), and Channakesava Murthy (ZSI, Kolkata) for data on the specimens in collections under their care.

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Appendix 1. Comparative material examined.

Trimeresurus albolabris (17 specimens). China. NHMUK 1946.1.19.85, NHMUK 1946.1.23.73 (Syntypes) “China.” MNHG 1464.88–89 “Tung Kum, Canton.” NMW 23927, “Koksingas Port.” NMW 23905:2, 23905:5–7, “Hainan, Ting-An.” NMW 23626.4–5 “Hongkong.” ZMB 27669 “S-Kuang-tung.” ZMB 52600, “Fung Wan.” ZMB 66282 “Lu Kung, Katon.” ZMB 66283 “N-Kuantung.” Vietnam. CIB GV2019111704–5, “Tam Dao.”

Trimeresurus cf. *albolabris* (29 specimens). Vietnam. NMW 23901.8 “Phuc-Son, Annam.” NMW 23904.3–5, NMW 23920.7 “Annam.” NMW 23920.3 “Saigon.” Thailand. NMW 19528 “Thailand.” NMW 23901:3–4 “Dom Rek.” NMW 23926.1, NMW 23926.6–9, NMW 23930.1–2 “Pu-Kin.” NMW 27946.2–3, 27946.5–6 “Hills of Bangkok.” NMW 23898.1–2 “Don-Pia-Fei.” ZMB 70196 “Surat Thani.” Indonesia. NMW 23901.6, 23926.1–3 “Java.” MNW 23902 “Tasikmalaja, W Java.” RMNH 17189 “Sumatra.”

Trimeresurus septentrionalis (18 specimens). Nepal. CAS 135750 (Paratype) “Nähe Pokhara.” MHNG 1404.31. (Holotype) MHNG 1400.18, 24–26, 29–32, 34–39, 45, 47 (all Paratypes) “Nähe Pokhara.”

Trimeresurus insularis (7 specimens). Indonesia. NHMB 12773 (Holotype) “Soe, Timor.” NMW 39581 “Bali.” MNHN 4056, “Timor Island.” MNHN 4057, “Indes Orientales.” MNHN 2002.0402, “Wetar Island.” SMF 76352, 76353, “Flores Island.”

Trimeresurus erythrurus (22 specimens). India. NHMUK 1940.3.9.22 “Naga Hills.” NMHW 23903:1–2, Guwahati, Assam. ZSI 3052, ZSI 3002, ZSI 3013, ZSI 3045–46 “Samagooting, Assam.” ZMH R-6933 “Himalaya.” Myanmar. NHMUK 61.10.2.5–6, 1908.6.23.96 “Rangoon,” ZMH R-6934 “Rangoon.” CAS 220377, 240036, 204989 “Rakhin.” CAS 239352, 239502, 239511, 40120 “Ayeyarwaddi State.” CAS 240120 “Kakhim State.” CAS 243175 “Magway.”

Trimeresurus fasciatus (4 specimens). NHMUK 96.4.29.46 (Holotype), “Jampea Island,” now Tanahjampea, Province of Sulawesi Selatan, Indonesia. MNHN 1999.9071, MNHN 2002.0401–02, Tanahjampea, Province of Sulawesi Selatan, Indonesia, through the pet trade.